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# Exposure of Spraymen to Pesticides

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**Values for potential dermal and respiratory exposure, and for total exposure in terms of fraction of toxic dose were determined for 11 different pesticides during orchard spraying with air-blast application equipment. Highest total exposure was calculated to be only 1.12% of a toxic dose per hour for workers applying the organophosphorus compound, carbophenothion, the most toxic compound in the study. There was considerable variation in exposure to a specific pesticide depending on certain factors, mainly wind. Potential dermal exposure to each compound was much greater than potential respiratory exposure. Workers were subjected to relatively small fractions of a toxic dose each day as they applied the compounds that were studied.**

EVALUATION of the hazard to the health of workers using pesticides requires knowledge of the amount of exposure they receive while performing various jobs related to the preparation and use of these compounds. For measurement of exposure, both direct and indirect methods are available. The direct methods are those which utilize techniques to either entrap the toxic material as it comes in contact with the workman, or to remove the retained toxicant from exposed body areas at the end of an exposure period. The amount of toxicant trapped or removed is then a direct measurement of the potential exposure during a given period of time. The indirect methods involve the detection of the pesticide or its metabolite in body tissue or body excreta, or the measurement of some pharmacologic effect of the toxicant on the exposed individual.

An earlier publication from this laboratory summarized those published studies of exposure of workers to pesticides which have been carried out, and reported results of direct measurements of dermal and respiratory exposure for 31 different work activities involving 10 different pesticides.[1] As a supplement to these studies the present paper reports the results of direct pesticide exposure experiments on agricultural spraymen for 11 additional pesticides.

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**Potential Dermal and Respiratory Exposure to Selected Pesticides***

| Compound | Formulation | Rate of Application (lb Active Ingred/Acre) | No. of Samples Analyzed | | | Exposure | | |
|---|---|---|---|---|---|---|---|---|
| | | | Dermal | Respirator | Value | Dermal (mg/hr) | Respiratory (mg/hr) | Total % Toxic Dose/hr |
| Binapacryl | 0.03% spray | 2 | 180 | 13 | Range | 4.4-79.9 | 0.01-0.36 | 0.01-0.15 |
| | | | | | Av | 29.6 | 0.07 | 0.05 |
| Carbophenothion | 0.03% spray | 4 | 36 | 5 | Range | 9.6-87.1 | 0.02-0.29 | 0.26-2.38 |
| | | | | | Av | 41.3 | 0.11 | 1.12 |
| Diazinon | 0.06% spray | 4 | 196 | 15 | Range | 0.3-157.5 | <0.01-0.39 | <0.01-0.26 |
| | | | | | Av | 23.4 | 0.06 | 0.04 |
| Dilan | 0.08% spray | 7 | 42 | 4 | Range | 6.4-217.6 | 0.05-0.65 | <0.01-0.05 |
| | | | | | Av | 75.1 | 0.26 | 0.02 |
| Dicofol | 0.04% spray | 2.3 | 98 | 8 | Range | 0.4-150.6 | 0.03-0.07 | <0.01-0.20 |
| | | | | | Av | 30.5 | 0.05 | 0.04 |
| Dinobuton | 0.06% spray | 5 | 36 | 3 | Range | 3.4-63.2 | 0.01-0.04 | <0.01-0.06 |
| | | | | | Av | 31.0 | 0.02 | 0.03 |
| Endosulfan | 0.06% spray | 3 | 168 | 15 | Range | 0.6-95.3 | 0.01-0.05 | <0.01-1.05 |
| | | | | | Av | 24.7 | 0.02 | 0.27 |
| Ethion | 0.06% spray | 4 | 197 | 14 | Range | 0.6-250.1 | <0.01-0.14 | <0.01-1.47 |
| | | | | | Av | 44.2 | 0.04 | 0.26 |
| Morestan | 0.03% spray | 2 | 116 | 12 | Range | 0.10-115.0 | <0.01-0.08 | <0.01-0.08 |
| | | | | | Av | 23.7 | 0.02 | 0.02 |
| Perthane | 0.12% spray | 4 | 102 | 13 | Range | 1.5-355.1 | <0.01-0.44 | <0.01-<0.01 |
| | | | | | Av | 59.4 | 0.14 | <0.01 |
| Tetradifon | 0.03% spray | 2 | 116 | 5 | Range | 2.0-149.9 | 0.01-0.17 | <0.01-<0.01 |
| | | | | | Av | 35.4 | 0.07 | <0.01 |

* Determined by direct method.

## Materials and Methods

All tests were performed on spraymen operating tractor-drawn power air-blast equipment as they applied pesticides to fruit orchards in central Washington. This type of application was chosen for study because it generally produces greater potential exposure to the operator than do most other methods of application. The hazard results from the fact that air-blast equipment directs spray upward into the air with great force and hence it is more likely to drift onto the operator.

Estimation of the amounts of dermal and respiratory exposure that workers would potentially incur, as well as calculation of total potential exposure in terms of percentage of toxic dose, followed the techniques and procedures described in detail by Durham and Wolfe.[2] A total of 1,287 analyses of dermal exposure pads or hand rinses and 107 analyses of respirator pads were carried out in the present study. Chemical analysis of the samples was by electron-capture gas-liquid chromatography.

## Results and Comment

The values for dermal and respiratory exposure and for total potential exposure in terms of fraction of toxic dose per hour of work as determined for the 11 compounds in the present study are shown in the Table. The most toxic pesticide in the study was the organophosphorus compound, carbophenothion. Even though the exposure value of 1.12% (range, 0.26% to 2.38%) calculated for this insecticide was higher than those for other compounds in the study, this value represents only a very small fraction of a toxic dose per hour of exposure. Of the nonorganophosphorus compounds studied, the greatest potential exposure, in terms of fraction of toxic dose received per hour, was from endosulfan with an average value of 0.27% (range, < 0.01% to 1.05%). This chlorinated hydrocarbon compound was the most toxic nonorganophosphorus compound in the study. The greatest potential exposure, in terms of quantity of pesticide that the workers were subjected to, was for dilan and 1,1-dichloro-2, 2-bis (p-ethylephenyl) ethane (Perthane); however, the fraction of toxic dose received per hour of work was very low because these compounds are of low dermal and oral toxicity.[3]

Exposure correlated better with spray concentration and exposure time than with the amount of pesticide applied per acre. It was found that in orchard applications involving air-blast spray equipment, other factors come into play that make it difficult to correlate the degree of exposure with the amount of pesticide applied in a given period of time, the amount applied per acre, or with the amount of acreage covered. With a constant output of pesticide, the speed at which a pesticide is applied varies considerably, as size and spacing of trees change within a given acreage. Thus, any increase or decrease of traveling speed may not only change the amount applied per acre, but also change the exposure time of the operator as he sprays a given acreage. At the same time other important factors, such as wind, may come into play.

Considerable variation in average values for dermal and respiratory exposure was found. In this, as well as in earlier studies, we have found no dependable explanation for all of the observed variations. Each exposure situation seems to involve a different combination of factors that affect exposure. Among the several potential factors considered were temperature and humidity. Under conditions of high temperature and low humidity a reduction in droplet size may occur while the droplets are moving through the air. The use of application equipment that produces a high percentage of very small droplets, and especially the application of pesticides that are relatively volatile, could make droplet size a significant factor. However, when using the type of equipment and pesticides involved in this study, it is doubtful that there was enough reduction in droplet size to cause a marked difference in respiratory vs dermal exposure.

Of the compounds in the present study, only carbophenothion and endosulfan have been reported to have caused poisoning from occupational exposure. These cases involved pesticide formulating plant workers exposed to endosulfan[4] and workers mixed carbophenothion dust or applying the 2% dust to the soil at the base of sugar cane stool.[5] It is pertinent to note that these two compounds are the pesticides showing the two highest potential exposure values in the present study. Thus, experience in usage correlates well with the relative exposure values for the compounds studied.

The present results indicate that workers who apply any of these pesticides under conditions similar to those in this study, would be exposed to relatively small fractions of the toxic dose during each hour or day of work. In fact, the toxicity, as well as the exposure levels (percentage of toxic dose per hour), of some of the compounds studied is so low that it is doubtful that occupational poisoning associated with their use might occur. However, the importance of minimizing exposure to compounds of even low toxicity should not be overlooked.

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